Advantages of High Molecular Weight PVDF Binder in Lithium Ion Cells

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Introduction

- Polyvinylidene fluoride (PVDF) polymers are widely used as binders in lithium ion batteries.
- Certain grades of PVDF are synthesized especially for binder use.
- The polymerization process and the molecular weight make a difference in binder processing and performance.

Key Attributes of Battery Binder

Chemical nature of binder

Good *adhesion* to metallic collectors

Good *cohesion* between active material particles

Processing aspects

Good *solubility* in industrial solvents

Good *homogeneity* of slurries at RT

No peel-off

No cracking

GOOD ELECTRODE

Good initial capacity

Good cycling behavior

Electrochemical properties

Experimental

materials

PVDF materials used in this work			
Code	**Polymerization Process**	***Solution Viscosity (cp)**	**Remark**
A	Emulsion Polymerization	501	Arkema Commercial Product
B	Emulsion Polymerization	1081	Arkema Developmental Grade
C	Suspension Polymerization	390	Commercial Product
*Solution viscosity refers to the one of 5 wt% solution in NMP, measured at 25°C using a Brookfield viscometer			

Emulsion vs Suspension PVDF

- Inherent Advantages of Emulsion Grades
  - Dissolves Easier and Faster in Solvent
    - Due to Nanometer-scale Particle size Versus Micron-scale Particle Size
  - Very Mono-dispersed Particle Size Distribution
    - Provides better control during dissolution process
  - Super High Molecular Weight PVDF Can Be Synthesized

Experimental

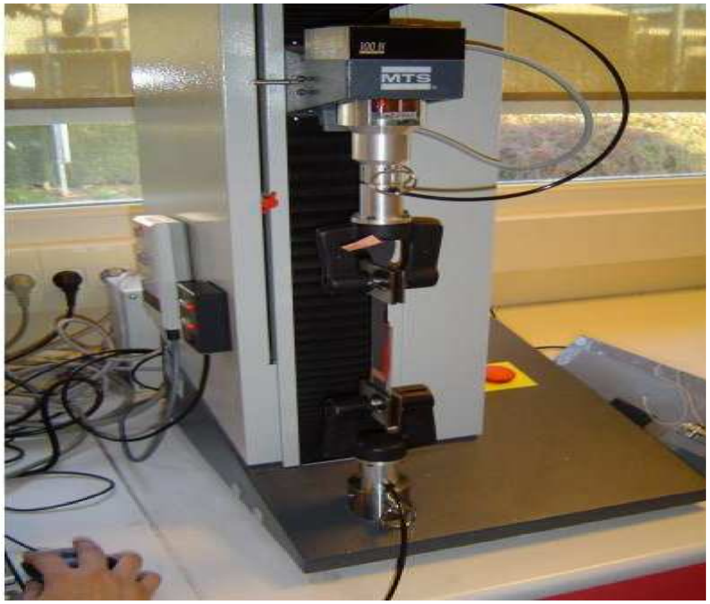
Slurry Formulations

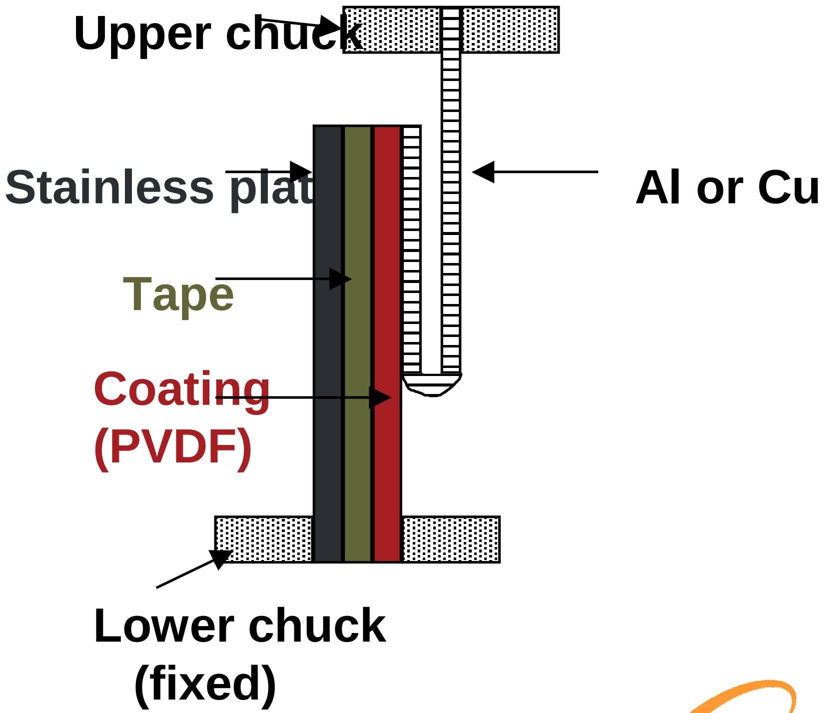
Slurry formulations of LFP cathode				
Electrode ID	**PVDF Type**	**Weight Percent**		
		PVDF	**Total Solids**	**NMP**
PE# 1	A	5.0%	49.5%	50.5%
PE# 2	B	5.0%	48%	52%
PE# 3	C	5.0%	49.5%	50.5%
The NMP concentration was adjusted to give a viscosity value compatible with a good coating.				

Experimental

electrodes

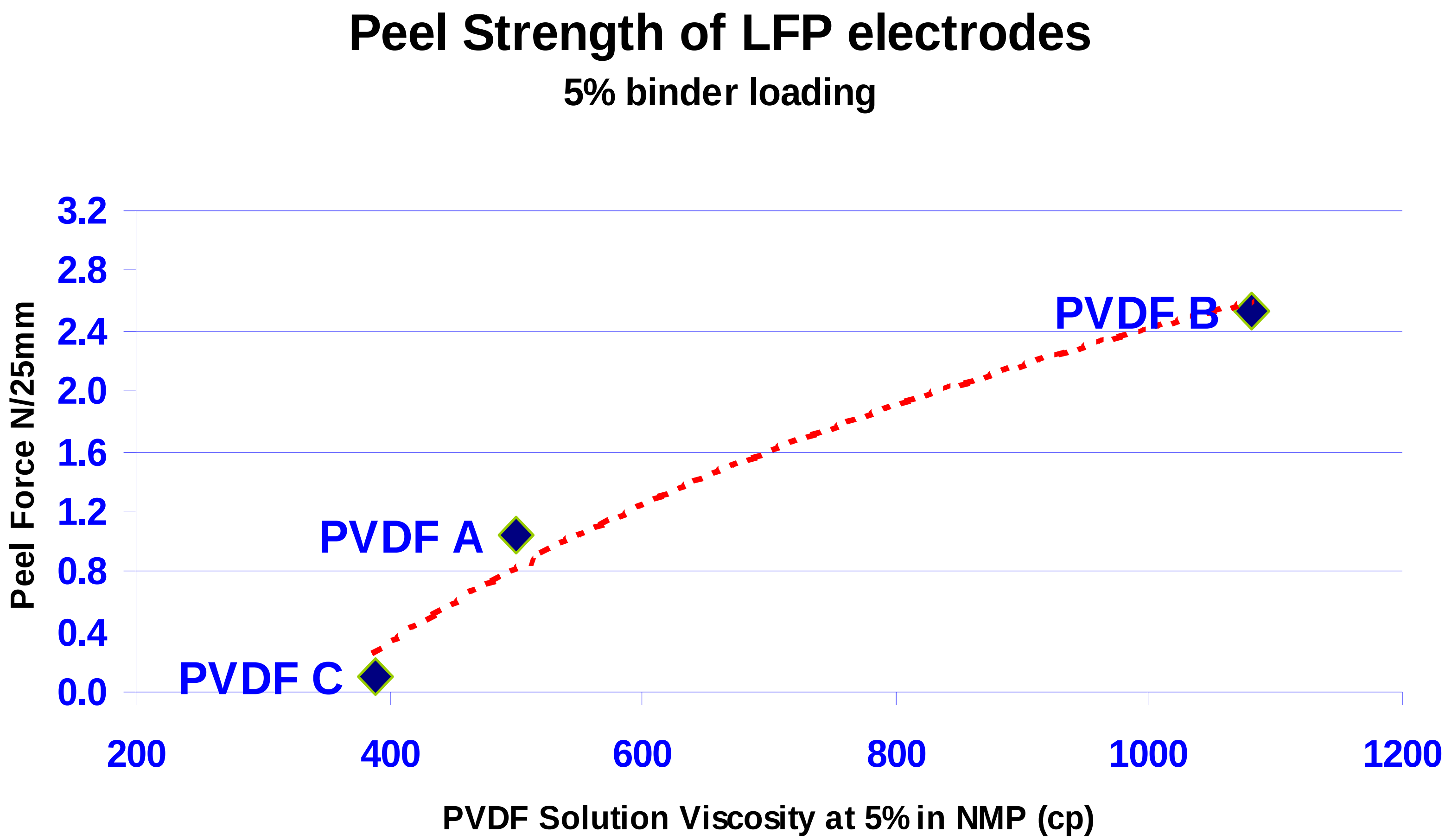
- Cathode specimens were evaluated for peel strength using an Instron Tensiometer
- Electrodes were used to fabricate 18650 cells using a standard anode and electrolyte





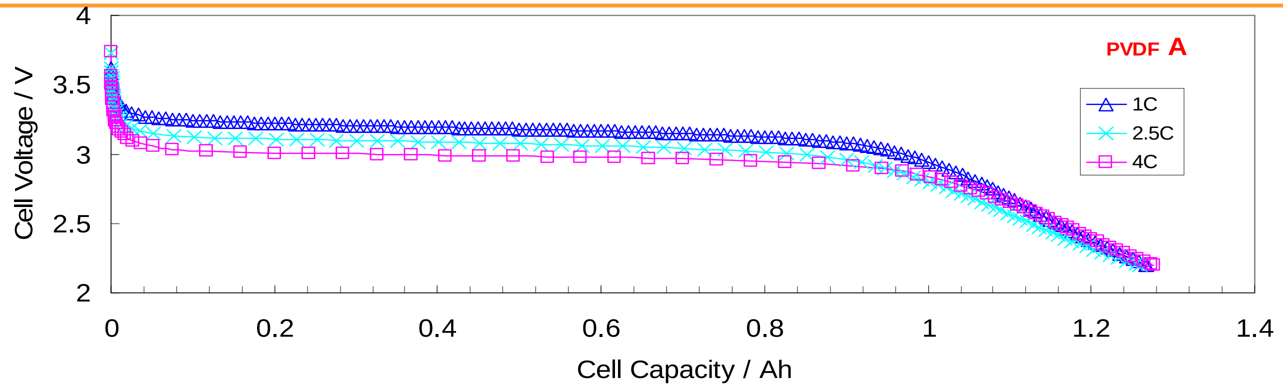
Results

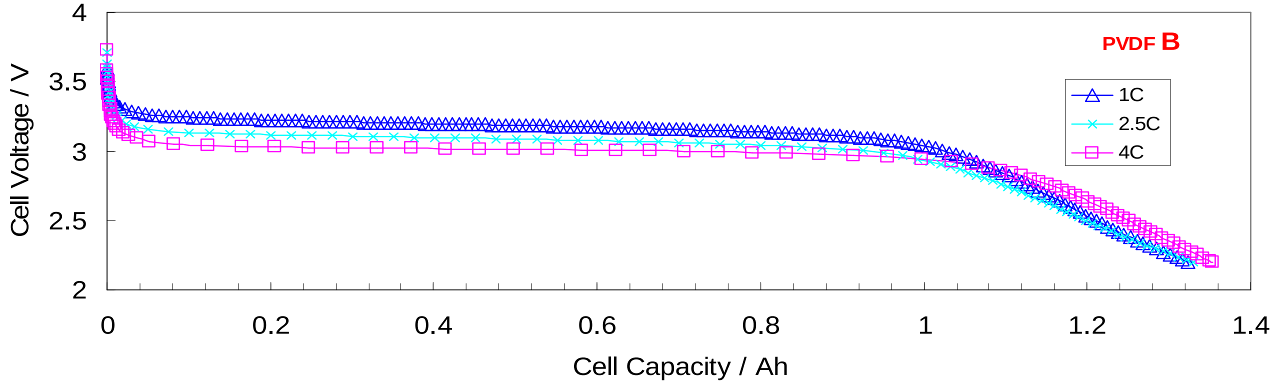
peel strength

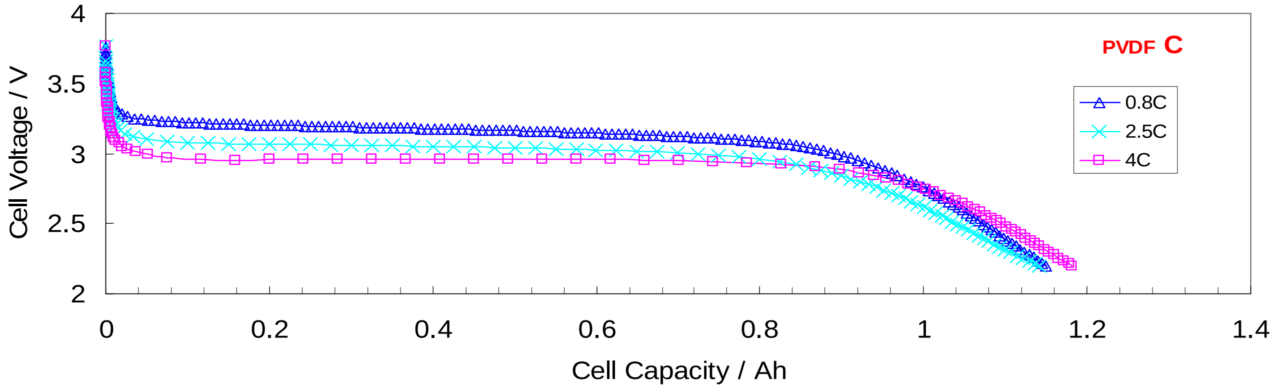


Results

cell performance







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Conclusion

- The peel strength of the cathode was profoundly affected by the MW of the PVDF
- Emulsion-polymerized grades can provide higher peel strength at the same loading as suspension-polymerized grades
- The cell capacity can be significantly improved by using PVDF homopolymer of super high molecular weight

Appendix

- Contact information
- Solvents for Kynar® PVDF resins
- Solution viscosity chart

Contact Us

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Solvents for Kynar® resins

Active Solvents

- Dimethyl Formamide (DMF)
- Dimethyl Acetamide (DMAc)
- Tetramethyl Urea
- Dimethyl Sulfoxide (DMSO)
- Triethyl Phosphate (TEP)
- N-Methyl-2-Pyrrolidone (NMP)

Latent Solvents

- Acetone
- THF
- MEK
- MIBK
- Glycol Ethers
- n-Butyl Acetate
- Cyclohexanone
- Isophorone
- DMC, DEC, PC

Solution Viscosity improvement of Kynar® PVDF